

# Natural Gas Utilization and its Effect on Nigeria's Economic

Ubani, C.E.&Ani, Goodness O.

University of Port Harcourt, Port Harcourt

gpasting@gmail.com

**Abstract :** *Natural gas is a mixture of hydrocarbon gases, non-hydrocarbon gases: Carbon Dioxide (CO<sub>2</sub>), Hydrogen Sulphide (H<sub>2</sub>S), and Nitrogen (N<sub>2</sub>), and sometimes metals, depending on the formation. Due to the different types of components in natural gas, it finds wide application either as an energy source, for power industries, or as feedstock for the chemical and petrochemical industries, or as fuel for domestic usage. Therefore, there are huge benefits in utilizing natural gas. Nigeria, with huge natural gas reserves of above 186 Tcf, can affect positively on its economy via utilization of its natural gas. The Nigeria Gas Master Plan and its Strategic Themes, which is a road map in the utilization of natural gas was examined alongside various major natural gas projects in Nigeria. Generally, the Gas Master Plan is to diversify the economy by allowing local and international investors to invest in the natural gas business rather than flaring it. Potential areas in which natural gas can be utilized to boost the Nigeria economy were listed and analyzed based on Nigeria's natural gas reserves and production history. Results obtained show that Nigeria is number one in Africa and eight in the world in natural gas reserves. In production, Nigeria is third in Africa and ninth in the world. However, in the past utilization of the produced gas is minimal resulting in gas flaring, which has affected negatively on the economy and environment. The various areas of utilizing this wealth (Natural Gas), found underground, has shown that if the Gas Master Plan is fully adhered to, the Gross Domestic Product per Capital will increase, unemployment rate will reduce to the barest minimum.*

**Key words:** Natural Gas Liquid, Gas Utilization, Compressed Natural Gas (CNG), Gas Master Plan, Gas-to-Liquid (GTL), Liquefied Natural Gas (LNG). Heating Value

## 1. Introduction

Natural gas is a source of energy often used as heating fuel, cooking gas, fuel for vehicles, fuel for generating electric power, and petrochemical feedstock in the manufacturing of plastics and other commercially important organic chemicals. The components of natural gas are hydrocarbon gases (methane, ethane, propane, butane, pentane and heavier hydrocarbons), non-hydrocarbon gases (carbon dioxide, hydrogen sulphide, nitrogen and water vapour), and sometimes mercury. Natural gas is not directly searched for during the exploration of crude oil, it is only by accident that it is found either with crude oil or alone. However, natural gas is found in deep underground formations either as associated gas, non-

associated gas or as condensate. Associated gas is produced during the production of crude oil via separators. Due to what producers perceived as unimportant neighbor of crude oil, they channeled the produced gas to flare headers where they are burnt off. Natural gas requires processing before it can be utilized.

The amount of energy obtained when a unit volume of natural gas is burnt, is measured in British thermal unit (Btu) and it is called the Heating Value.

Nigeria is a growing economy that depends on both crude oil and natural gas for domestic and international market; however, less attention is being given to the natural gas, which results to flaring of the gas. The consequence is pollution of the environment (air, water, and soil). Inadequate storage system and processing facilities, inadequate domestic and industrial utilization of the gas; lack of natural gas transmission, distribution systems, and irregular pricing policy has been the reason for the flaring of the natural gas.

This paper examines the sectors where natural gas utilization can be encouraged and improved in Nigeria, economic benefits associated with the utilization of natural gas in Nigeria, and assessment of the economic impact of the use of natural gas in Nigeria by domestic users and industries, and the export of the gas to foreign countries.

## 2. The State of Natural Gas And its Utilization in Nigeria

Nigeria's natural gas reserves of above 186 Tcf (of proven natural gas reserves), makes her number one in Africa and eight globally, as shown in Figure A1 and A2 of Appendix A. Its natural gas has little or no sulphur content depending on the formation of origin and rich in Natural Gas Liquid (NGL). Discovery of natural gas in Nigeria is incidental, since exploration was aimed at crude oil. Prior to 1999, natural gas produced alongside crude oil were flared, leaving the gas domestic market largely underdeveloped.

According to Ojinnaka (1998), flaring of natural gas has enormous loss of revenue that could have been realized if the gas was utilized. However, he notes that some percentage of the gas is sold in the domestic market to industries like cement, brewery, glass and aluminum as complement to the use of diesel and fuel oil to power their heavy-duty machineries.

Natural gas production has increased enormously from 0.4 Bcf/d in 1990 to 4.8 Bcf/d in 2015 (BP Statistical Review, 2015). However, Environmental Impact Assessment (EIA) Report (2015) on Nigeria's oil and gas sector, reveals that Nigeria flared 12% of gross production, or 379 Bcf of its associated gas production in 2015, making Nigeria the fifth-largest natural gas flaring country, down from the second position it held in 2011.

In the last few years, there has been improvement in the utilization of natural gas in Nigeria; Shell Petroleum Development Company (SPDC) and Chevron route their produced natural gas to NLNG in Bonny, where the gas is process to LNG, and then exported to other country as domestic fuel. In addition, the Olokola LNG and the Brass LNG project in Nigeria has experience a new face of development. The growth of the power sector is dependent on the direct growth in gas demand, since recent design in power plants are gas fired.

Ojinnaka (1998) says gas is a close substitute for other fuels in electricity generation, a complement to crude oil in revenue earning, a feedstock for fertilizer and petrochemical industries and environmentally more friendly than crude oil and coal. However, natural gas in Nigeria has a problem and that is, most of it is being flared which leads to adverse effect on the environment.

### 3. Nigeria Gas Master Plan

In order to utilize the enormous gas reserves in Nigeria, the Federal Government set up a Gas Master Plan. The Gas Master Plan of Nigeria paved the way for utilization of natural gas rather than flaring it. The plan is to allow private sectors (both International and local) invests in the gas business to develop the gas resources in the country, which will have direct impact on the growth of the Gross Domestic Profit of the country. In February 3, 2008, the Nigeria Gas Master Plan was approved and the major aim of the plan was to grow the Nigerian economy with gas by pursuing three key strategies:

#### First Strategy:

Stimulate the multiplier effect of gas in the domestic economy

#### Key Objectives:

- Facilitate gas to power
- Domestic Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG)
- Encourage emergence of natural gas based industry in the production of Methanol, fertilizers, polymers etc

#### Second Strategy:

Position Nigeria competitively in high value export markets

#### Key Objectives:

- Selective participation in high value markets
- Strategic positioning for growth

#### Third Strategy:

Guarantee the long-term energy security of Nigeria

#### Key Objectives:

- Balancing trans-generational needs to manage exploitation

Figure 1 shows the strategic theme of the Gas Master Plan (Ige, 2014)

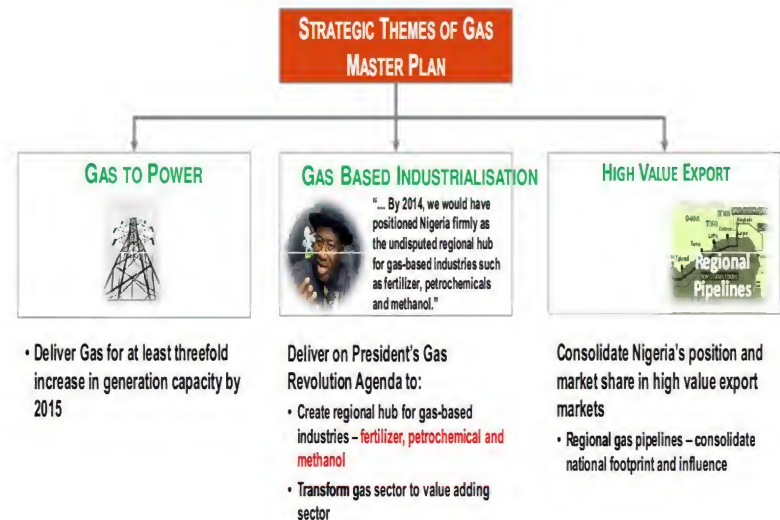


Figure 1: Strategic Theme of the Gas Master Plan

If the Gas Master Plan will add value to the Nigeria economy, then the Federal Government need to create the right environment for local and international investors to invest, in order to achieve the key objectives. However, various natural gas projects and their success are considered in this paper to determine their contribution to the Nigeria economy via the strategic themes of the Gas Master Plan.

### 4. Major Gas Projects in Nigeria.

In order to fully utilize the enormous gas reserves, Nigeria National Petroleum Company (NNPC) and other major Exploration & Production (E&P) operators are currently embarking on several gas utilization projects, to key into the key objective of the Gas Master Plan.

#### 4.1. Nigeria Liquefied Natural Gas (NLNG) Projects

The NLNG plant is one of government's biggest investment in River State. The plant is design to processed natural gas to obtain the following major products: Liquefied Natural Gas (LNG), Natural Gas Liquid and Liquefied Petroleum Gas (LPG). The LNG and Gas Natural Liquid are exported to various country across the globe to increase revenue. The company was incorporated on May, 1989 to tap into the enormous natural gas reserves in Rivers State and other States in the country. The company began operations in 1999 with a production capacity of 22 million metric tonnes per annum of LNG and 5 metric tonnes per annum of Gas Natural Liquid. This production capacity is expected to increase to 30 million tonnes per annum of LNG when train 7 is finally completed (King, 2015). Eighty percent (80%) of domestic cooking gas in the country, is expected to come from NLNG. The NLNG plant, with 6 trains was built with a total investment cost of \$9.348 billions. The company has about 23 ships that transport its products to other country. These countries include United State, United Kingdom, Europe Gulf of America, Middle East



and Asia. It also sell its product to major buyers that utilizes this gas for industrial purpose.

#### 4.2. Gas-To-Liquid Project

The Escravos Gas-to-Liquid (EGTL) project is a Chevron project and was design to process the rich gas resources of the Escravos field via Fischer-Troph Process. The Escravos Gas-to-Liquid plant which was design with a total investment cost of \$1.7 billion, has a capacity of 34,000 barrel per day. This is expected to increase to 120,000 barrel per day within ten (10) years of completion. The plant was design to convert natural gas into Premium Motor Spirit (PMS), diesel, and GTL naphtha products, which are environmentally friendly fuel. The EGTL project will form an integral part of the owner's overall gas utilization strategy that includes domestic natural gas sales, regional natural gas sales through the West Africa Gas Pipeline (WAGP) and international sales of GTL project.

The EGTL, the first major gas project to gather and process associated natural gas in Nigeria, came on stream in 1997 and it is a key project in ChevronTexaco's initiative, in line with the Nigeria Gas Matser Plan to reduce flaring of natural gas.

#### 4.3. Natural Gas Liquid Project

The Oso Natural Gas Liquid (NGL) project is a Mobile Producing Nigeria Unlimited project, which is located in Akwa Ibo State in Nigeria. The OsoNGL plant started production of NGLs in August, 1998. The plant has a design capacity of 600MMcf per day, with feed gas coming from the Oso condensate field and other associated gas production fields. The plant is expected to recover 350Mb of NGL over its life without any impact on condensate production. This is a significant development that is tied to the Nigeria Gas Master Plan, to reduce natural gas flaring. The total investment cost of the Oso Condensate project has no definite costuntil date. However total investment cost was estimated to be \$335.38 million.

#### 4.4. Gas Injection project

The Belema Gas Injection Project is an NNPC/Shell Joint Venture project. The major objective of the project is to reduce gas flaring in Shell's various flow stations and utilizing the produced gas in the following ways: re-injecting some of the produced gas to maintain reservoir pressure, using some for gas lifting, as fuel for local industries and the others for Non-Associated Gas projects.

#### 4.5. Gas Pipeline Project

The West African Gas Pipeline Project (WAGP), is a joint venture project between Chevron (having 36.7% shares), NNPC (having 25% shares), Shell Overseas Holdings Limited (18%), SocieteTogolaise de Gaz and Societe Ben Gas each 2%. (Akintunde and Onyekonwu, 2016). The WAGP is to transport gas from Nigeria to Africa country: Ghana, Benin, and Togo. This project will traverse about 618km high pressure natural

gas pipeline to transport natural gas produced in Niger Delta to power generation and industrial facilities in Ghana, Togo, and Benin. The initial capacity of the pipeline is 170MMscf/d (Akintunde and Onyekonwu, 2016).

Other Natural Gas Project are the Trans-Sahara Gas Pipeline and the Domestic Gas Distribution Network.

### 5. Potential Areas of Natural Gas Utilizationsand Economic Impact

Natural gas is an important energy source for power plant to generate electricity, for many industries to drive heavy-duty machineries, heat for domestic usage, and feedstock for petrochemical industries. It is the cleanest fuel when combusted, releasing little or no harmful by-product to the environment and contribute the least amount of Green House Gas (GHG). The following are potential areas in which natural gas can be utilize in Nigeria to improve the economy and the wellbeing of its citizenry.

#### 5.1. Gas to Power

Gas turbine and steam turbine are two major turbine that generate electricity via a rotating shaft. Both turbine utilizes natural gas as the primary fuel for energy input to the turbine. While gas turbine utilizes the heat energy generated from the combustion of the gas to drive the turbine shaft, steam turbine utilizes the heat energy to generate super dry steam, which drives the turbine shaft. In both cases, the continuous rotation of the shaft can be converted to electricity, which is transmitted via high-tension cables to consumers. Nigeria plan to grow the gas supply to power sector from 600MMScf/d to 3.8 Bscf/d by 2015, with specific short to medium term focus on Power Holding Company of Nigeria (PHCN), National Independent Power Project (NIPP), Joint Venture IPP and third party IPP (Oniwon, 2011).

Figures A1 and A2 of Appendix A, shows that Nigeria is number one in Natural gas reserves in Africa and eight in the World. With these enormous gas reserves of over 186 Tcf, the power sector in Nigeria is expected to be the best in Africa and eight best in the world, with huge benefit to the economy, but utilization up to 2015, is bedeviled with gas flaring. Figure A3, shows that Nigeria is third in Natural Gas production in Africa, but consumption is minimal as shown in Figure A5. It means that, high percentage of the produced gas is flared. Small and Medium Scale Enterprise (SMEs) are heavily dependent on electricity. Once produced gas is utilize in the power sector, sale of gas will generate revenue, SMEs will grow and Gross Domestic Product (GDP) per capital and income will grow.

#### 5.2. Gas to Transport Industry

At this time when the state of the environment is a major concern to the world, Nigerian Government must think of a better way to reduce combustion product (flue gases) of gasoline from vehicle's exhaust. A better way to do this, is processing of the produced natural gas to Compressed Natural Gas (CNG), which is presently been used as fuel for vehicles.

It is not only environmentally friendly, it will increase GDP per capital, via sales of natural gas to gas processing company, it is cheaper, therefore, users will pay less and achieve more satisfaction than gasoline, and save more money for investment in the economy. At the retail level, CNG costs on average \$2 less than gasoline per gallon equivalent (Cabot Oil and Gas, 2011).

### 5.3. Gas to Petrochemical Industry

Products from natural gas processing plant are important petrochemical feedstocks for the production of intermediate and finished products. Product such as Ethane, Propane and Butane can be subjected to secondary processing to obtain Ethylene, Propylene, and Butene, which can be polymerize or process to obtain intermediate or finished products and important chemical such as plastics, soaps and detergents, solvents, drugs, fertilizers, pesticides, synthetic, fibers and rubbers, paints, epoxy resins, flooring and insulating materials. Industrialization drives an economy positively. Therefore, if the petrochemical industries that produce these products, are establish in Nigeria, then the economy will grow, GDP per capital will increase and unemployment rate will reduce drastically.

### 5.4. Gas to Cylinder

The demand for gaseous fuel for domestic purpose is high. Liquefied Petroleum gas (LPG) whose components are Propane C<sub>3</sub> and Butane C<sub>4</sub>, is one of the product obtained during the processing of Natural gas. LPG, in gas cylinder can be used as fuel for cooking in homes, restaurant, hotels, etc. Individual prefers LPG to conventional kerosene as fuel for cooking for the following reasons: (a) it is cheap and cylinders are easy to maintain, (b) it is clean when burnt, releasing little or no pollutants to the environment, (c) the amount of heat release is higher than that release by kerosene, so it take lesser time to process food. The heating value of LPG is 14.156 Btu/lbm (49MJ/kg) whereas the heating value for fuel oil is 12.278 Btu/lbm (42.5 MJ/kg) and for kerosene, lower heating value is 12.451 Btu/lbm (43.1 MJ/kg) and higher heating value is 13.347 Btu/lbm (46.2 MJ/kg). Again, users of LPG will spend less to process their food and save more for investment in the economy.

### 6. Conclusion

Nigeria has a huge opportunity to turn its present economic situation into a better economy, via Natural gas utilization in the power sector. Nigeria as a developing country can become developed country by allowing both local and international investors to invest in the natural gas sector, build natural gas industries to create employment. Natural gas utilization is a viable project and for it to thrive in Nigeria, the Federal Government must diversify the economy to create more wealth, put stringent measure to end gas flaring and clearly state out penalty for defaulters. Proper management of

produced natural gas can generate huge revenue for the federal government. The Nigeria Gas Master Plan or Gas resource utilization initiative should be pursued to enable gas based industries grow, thereby growing the economy. There should be continuous awareness of the benefit of LPG as domestic fuel. This should be a deliberate act in order to increase the number of LPG users.

### REFERENCES

- i. Akintunde, A.C. and Onyekonwu, M. (2016): "Review of Gas Resource Utilization Using Applicable Technology: A case Study of Nigeria", *Institute of Petroleum Studies (IPS), University of Port Harcourt, Nigeria*.
- ii. BP Statistical Review of World energy, June, 2016.
- iii. Chris, P. (2016): "Gas Flaring", *Energy Information Administration (EIA), United State of America*.
- iv. David Ige (2014): "Achievement of The Gas Master Plan: Strategies for Workable Road Map", *National Gas Summit, Calabar, Nigeria*.
- v. King (2015): "50 Facts About Nigeria Liquefied Natural Gas (NLNG)", *Information Guide Nigeria, Rivers State, Nigeria*.
- vi. Ojinnaka, I.P. (1998): "Energy crisis in Nigeria: The role of natural gas". *Bull Central Bank Niger*
- vii. Okoh, R.N. (2001): "Cost-benefit analysis of gas production in Nigeria". *The Nigerian Economic Society, Ibadan, Nigeria*.
- viii. Oniwon, A. (2011): "Gas Utilization for Long Term Clean Energy and Economics", *Society of Petroleum Engineers (SPE) Conference, NAICE, August*.
- xi. Ruud Weijermars (2010). "Value Chain Analysis of Natural Gas Industry-Lessons from the US Regulatory Success and Opportunities for Europe" *Journal of Natural Gas Science and Engineering* 2, 86-104.
- x. Adegbite, A. and Sina, S. (2011). "The International Comparative Legal Guide to Gas Regulation: A Practical Cross-Border Insight into Gas Regulation Work", *Global Legal Group Lagos, Nigeria*.

## Appendix A: Natural Gas Reserves, Production, and Consumption for Selected Countries in Africa and World

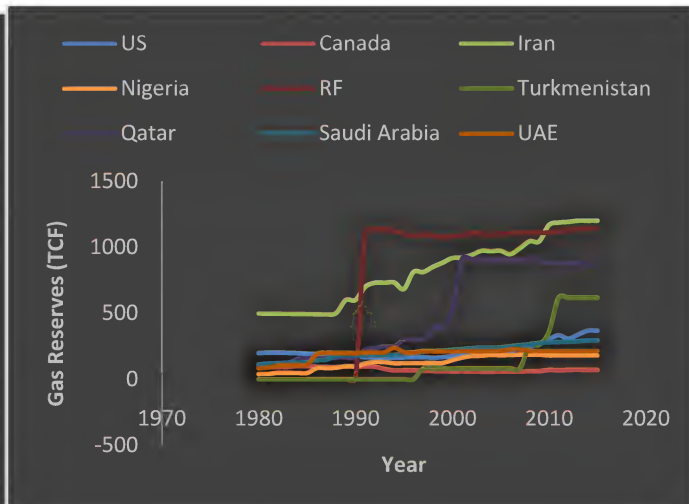
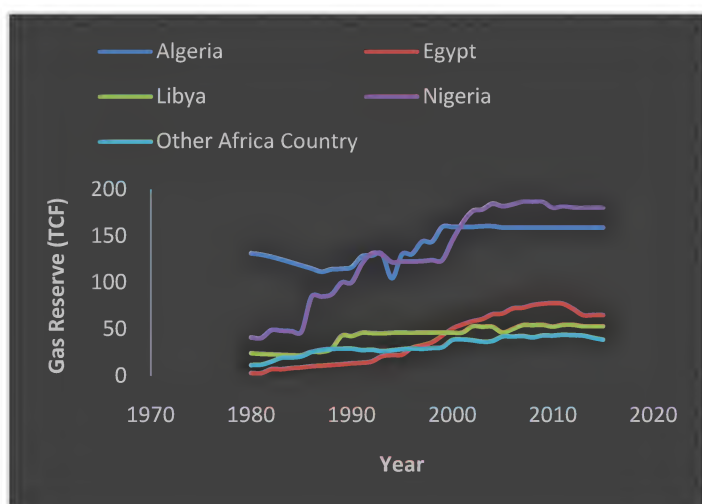


Figure A1: Natural Gas Reserves (Africa) Figure A2: Natural Gas Reserves (World)

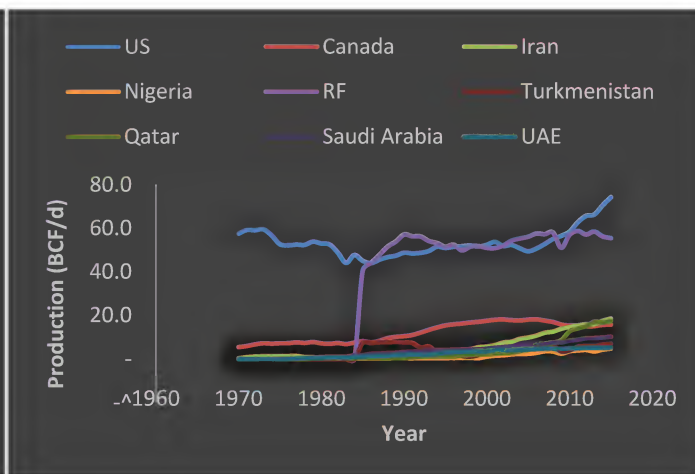
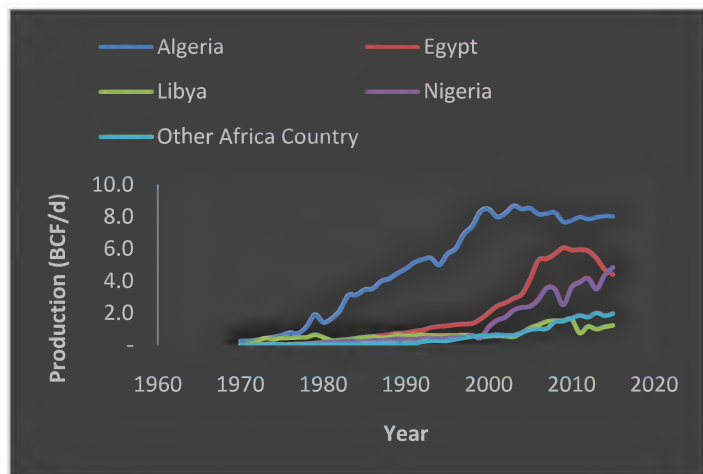


Figure A3: Natural Gas Production(Africa)Figure A4: Natural Gas Production (World)

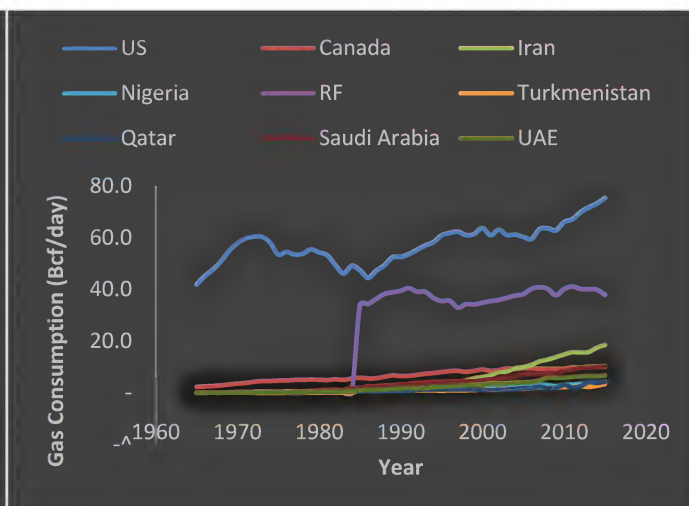
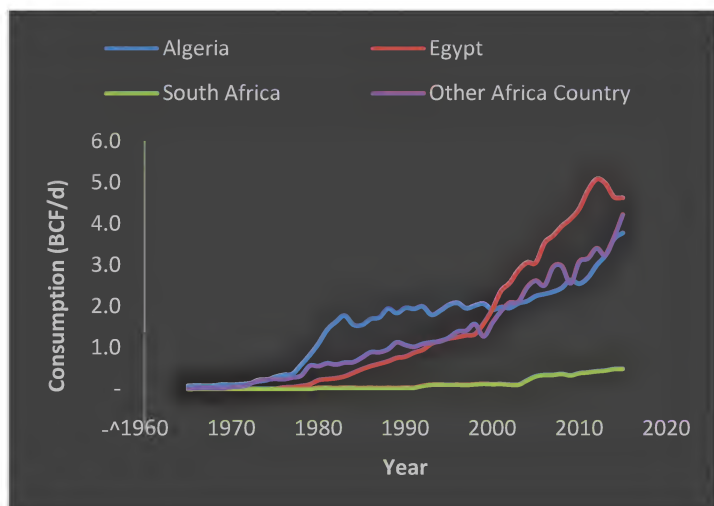


Figure A5: Natural Gas Consumption (Africa)

Figure A6: Natural Gas Consumption (World)

RF = Russian Federation

Data Source: BP Statistical Review of World Energy June 2015.